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# The Utilization of Calcium in Watermelon Rind Extract for Osteoporosis Drug Agent

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**Abstract**
Calcium is one of the essential minerals for the body, especially in the elderly and pregnant women. Using natural materials containing calcium is very important, especially natural materials that are only used as waste, such as watermelon rind. Watermelon rind has a calcium of 31 mg. Therefore, it is very efficient to be used. The manufacture of this osteoporosis drug does not refer to calcium from watermelon rind extract alone. However, it is supported by other herbal ingredients such as rhizomes (ginger, curcuma, turmeric, and fingerroot). The method of extracting calcium from watermelon rind used the destruction method. After being extracted, the extraction and some mixed with the rhizomes were tested, such as calcium levels, XRF, XRD, and FTIR tests. The result of the study showed that all samples were confirmed to have calcium. High calcium content of 13.30% was found in the watermelon rind extract sample from watermelon fruit measuring 6 kg mixed with rhizomes. All samples calcium level test results had a dominant value of 495 ppm.
**Keywords:** Calcium, osteoporosis drug, watermelon, rhizomes.

## 1. Introduction

Indonesia has a very diverse natural potential [1], known as an agricultural country, because most Indonesians work in agriculture. So, the government seeks to increase changes in agriculture that can improve people's welfare. Agriculture is changing rapidly, which could lead to a new issue with agricultural production waste that needs to be used effectively, such as fruit rind trash. One of them is the waste of fresh watermelon rind [2], which so far is still a waste that has yet to be utilized optimally [2], [3]. The primary ingredient of preference is watermelon because it is widely available and can be found throughout Indonesia, from Sabang to Merauke [4], [5]. Due to the benefits of the fruit, many farmers in Indonesia have also started growing watermelons. Fruit and seeds from the rind can be used, but they are not optimal for the rind [2].

Watermelon rind has recently shown great promise for research to enable direct application: for instance, it is employed as an antioxidant [6] in cosmetics [7]. This is where there is an update on the use of watermelon rind, which has long been utilized as an antioxidant in cosmetics. Although watermelon peel has more potassium and calcium, it also has fewer antioxidants than the fruit's flesh [5]. Calcium is the essential ingredient for use as a primary ingredient for osteoporosis drugs [6], [8]–[10]. Anybody can develop osteoporosis, but the elderly and postpartum women are particularly susceptible [8], [11].

It is known that foods like crab and lobster only have a small amount of calcium in them. However, as lobsters and crabs are pricey, it is important to look for cheaper alternatives to create calcium-containing components for osteoporosis medications. One of them is by utilizing calcium in fresh watermelon rind [2], [7]. Earlier studies showed that 100 g of watermelon rind contains 31 mg of calcium [5].

Watermelon rind extract can be stimulated by components used to make osteoporosis medications, but additional ingredients are required to maximize its support. Herbal or medicinal plants, such as rhizomes, are employed as materials (ginger, curcuma, turmeric, and fingerroot) [1], [12]. These substances can promote the production of osteoporosis medicine ingredients since they have been proven to have molecules that are antioxidants [1], [13]–[17], antibacterial [1], [14], [16], [17], anti-inflammatory [1], [13], [14], [16], [17], and also contain some calcium [9].

## 2. Method

### *2.1. Material*

The tools used for this research are a beaker, measuring cup, dropper, hot plate, funnel, spatula, petri dish, knife, blender, sample pot, oven, magnetic stirrer, digital balance, pH meter, and drawstring, regarding the ingredients used: watermelon (masses 4 kg, 5 kg, and 6 kg), rhizomes (ginger, curcuma, turmeric, and fingerroot), $HClO_4$, $HNO_3$, solution calcium kit, distilled water, 96% alcohol, filter paper, gloves, mask, tissue, plastic wrap, laundry soap, and label paper.

### *2.2. Synthesis*

There are three sections to this research. The first step is getting ready for the extraction of the watermelon rind. The watermelon rind extraction procedure using the destruction method is the second stage. The samples are ready for testing in the third stage, and some are combined with rhizome powder. Figure 1 depicts a summary of the research stages.

#### 2.2.1. Preparation for Sample Extraction Process

Watermelons of all kinds are first washed, then the rind and flesh are separated, and last, the rind is shaved and dried in the hot sun until it is totally dry. Depending on the weather, the drying process takes about three days. Use a blender to mix it into a powder after drying. Along with watermelon, rhizomes, including ginger, curcuma, turmeric, and fingerroot, each weighing up to 500 g, are also available. After being washed, shaved, and dried in the sun, they are mashed in a blender to create powders of the corresponding flavors.

#### 2.2.2. Watermelon Rind Extraction Process by Destruction Method

The 45 g of watermelon rind powder was taken, placed in a beaker glass, and combined with 225 ml of $HNO_3$, 7.5 ml of $HCl_4$, and briefly agitated to ensure that the mixture was equally distributed. The beaker glass was then covered with plastic wrap and left to stand for 24 hours. The following step was heated with a hot plate at 100 °C for 10 hours after being left to stand for 24 hours. This produced a clear color precipitate (destructed sample). Once heated, let it cool.

#### 2.2.3. Samples are Ready to be Tested and Some are Ready to be Mixed with Rhizomes

The sample from the destruction was placed in an oven at 250 °C for 1.5 hours until the brown powder was formed. The sample from the destruction was filtered using filter paper after the clear precipitate (sample) had cooled and was then washed with distilled water to pH 6 to neutralize the acid level. It is possible to evaluate or characterize brown powder using XRF, XRD, and FTIR and measure its calcium content using a calcium kit solution. Additionally, rhizomes that have been powdered are combined with 0.5 g of brown powder. A maximum of 0.5 g of each powdered rhizome was included in the combination. The next stage is to mill the brown powder and rhizome powder until they are homogeneous, after which it will be tested using the XRF, XRD, FTIR, and calcium test using a calcium kit solution.

### *2.3. Characterization*

Three characterizations are used in this study's material (XRD, FTIR, and XRF) to determine the properties of each sample. The existence of calcium peaks was determined using XRD characterization. FTIR analysis to identify the functional groups that the material possesses. XRF characterization is used to determine the sample's content and its percentage composition.

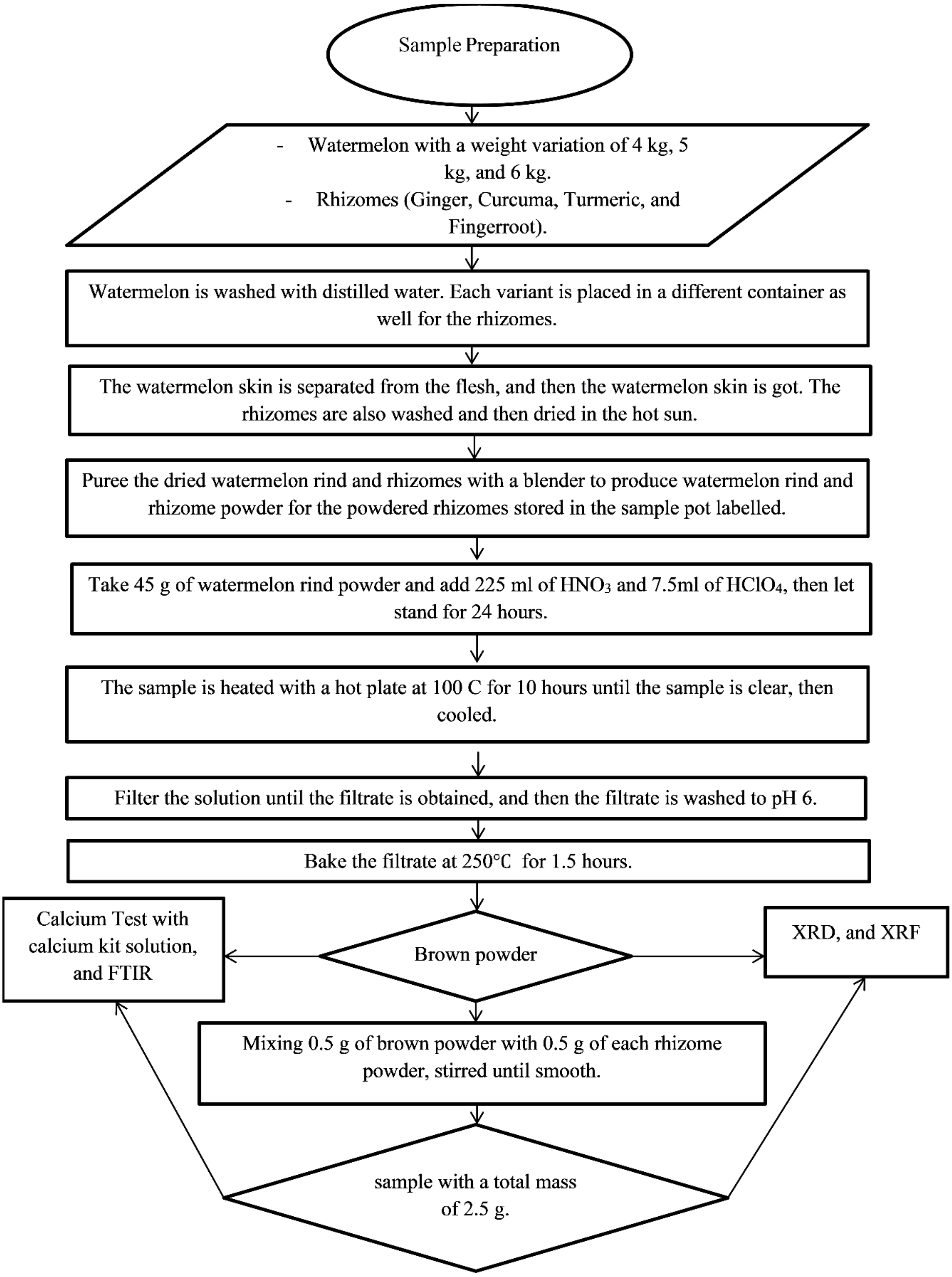


**Figure 1.** Research flowchart.

## 3. Result and Discussion

### *3.1. XRD Characterization Results*

The existence of calcium peaks was determined using XRD characterization. In order to smooth out the XRD data and produce a process graph, Origin software was used. Rietica software was then used to examine the plane hkl. The following are the findings from the XRD analysis of watermelon rind extract using 4 kg, 5 kg, and 6 kg watermelon variations, as shown in Figure 2a.

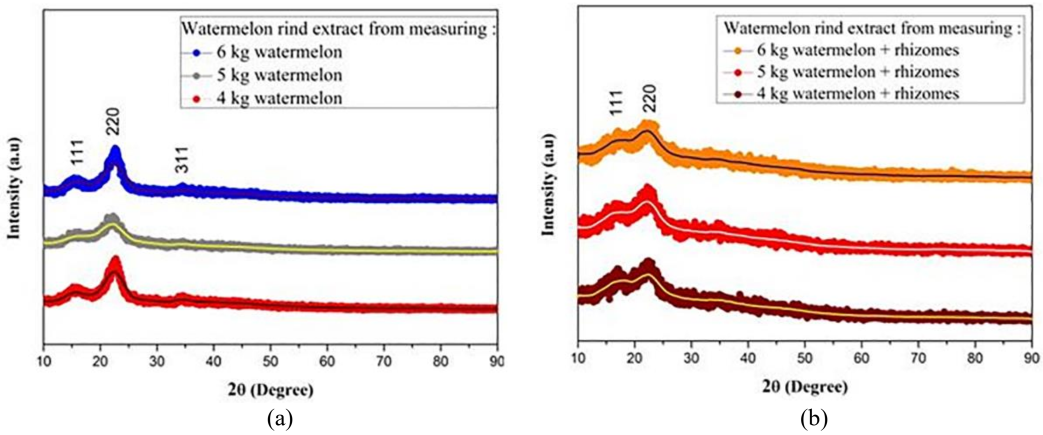


**Figure 2.** (a) XRD patterns of watermelon rind extract from watermelon fruit masses of 4kg, 5kg, and 6 kg, (b) XRD patterns of watermelon rind extract with mixed rhizomes.

Peaks in the hkl plane are shown in Figure 2a as 111, 220, and 311. According to earlier studies, the Ca-O and Si-O functional groups are in a phase, as shown by the peaks in the 220 hkl plane [18], [19]. The Fe-O functional group is in a phase, as shown by the peak of 311 [20], [21]. According to this result, the sample that underwent XRD characterization contained Ca because its peak was in the 220 hkl planes. Figure 2b also displays the XRD results from the watermelon rind extract combined with powdered rhizomes and the XRD results from the watermelon rind extract alone (ginger, turmeric, curcuma, and fingerroot). Only the peaks in the 111 and 220 hkl fields were seen in the XRD analysis of watermelon rind extract combined with rhizomes. The findings also reveal a peak in the hkl region of 220, indicating the presence of a Ca element in the sample.

### 3.2. *FTIR Results*

The FTIR characterization to determine the functional groups possessed by the material. The FTIR results were analyzed by comparing the data collected with existing references. The functional groups of the watermelon rind extract shown in Table 1. The FTIR results of watermelon rind extract from several variants are shown in Figure 3.

Based on FTIR analysis, it is proven that the presence of the Ca functional group at wave number 756 $cm^{-1}$ is owned by the watermelon rind extract sample from watermelon fruit size 4 kg. At wave number 765 $cm^{-1}$ is owned by the watermelon rind extract sample from watermelon fruit which measuring 4 kg, there is also a wave number indicating the presence of a Ca-O functional group at a wave number of 758 $cm^{-1}$ which is owned by a sample of watermelon rind extract from a watermelon measuring 6 kg. In addition to the FTIR results from watermelon rind extract, this study also obtained FTIR results from various variants of watermelon rind extract mixed with powdered rhizomes. The presence of functional groups can be described in detail in Table 2 and the spectrum of the FTIR results shown in Figure 4.

**Table 1.** Functional group watermelon rind extract from watermelon fruit measuring 4 kg, 5 kg, and 6 kg.

| Functional groups | Wavenumbers ($cm^{-1}$) in the sample of watermelon rind extract | | | Wavenumber ($cm^{-1}$) based on references | References |
|---|---|---|---|---|---|
| | 4 kg | 5 kg | 6kg | | |
| Fe-O | 544 | 550 | 500 | 400–600 | [22] |
| Mn-O | 668 | 673 | 678 | 500–750 | [20] |
| Ca-O | 756 | 765 | 758 | 750–800 | [23] |
| Si-O | 808 | 810 | 812 | 801–820 | [23] |
| C-O | 1092 | 1109 | 1173 | 1050–1200 | [24] |
| C-H | 1319 | 1317 | 1317 | 1300–1400 | [20] |
| O-H | 1612 | 1519 | 1700 | 1500–1700 | [25] |
| C-O | 2324 | 2322 | 2349 | 2320–2353 | [26] |
| C-H | 2850 | 2878 | 2897 | 2700-2900 | [22] |
| O-H | 3277 | 3307 | 3502 | 2930-3704 | [20], [25] |

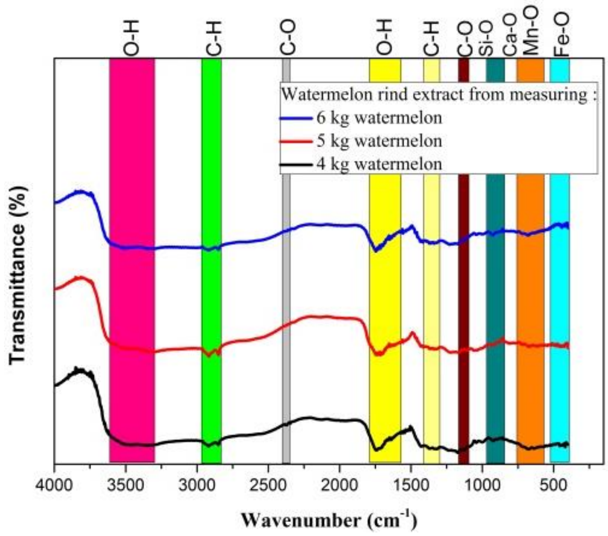


**Figure 3.** FTIR spectra of watermelon rind extract from watermelon fruit masses 4 kg, 5 kg, and 6 kg.

**Table 2.** Functional group of watermelon rind extract from various variations with rhizome powder.

| Functional groups | Wavenumbers ($cm^{-1}$) in the sample of watermelon rind extract mixed with rhizome powder | | | Wavenumber ($cm^{-1}$) based on references | References |
|---|---|---|---|---|---|
| | 4 kg | 5 kg | 6kg | | |
| Fe-O | 532 | 538 | 530 | 400–600 | [22] |
| Mn-O | 607 | 620 | 611 | 500–750 | [20] |
| Ca-O | 785 | 767 | 765 | 750–800 | [23] |
| Si-O | 862 | 862 | 862 | 801–820 | [23] |
| C-O | 1103 | 1103 | 1161 | 1050–1200 | [27] |
| C-H | 1371 | 1368 | 1336 | 1300–1400 | [20] |
| C-C | 1514 | 1514 | 1514 | 1425–1550 | [25] |
| O-H | 1631 | 1628 | 1606 | 1500–1700 | [26] |
| C=N | 2059 | 2133 | 2056 | 2100–2140 | [22] |
| C-O | 2330 | 2324 | 2349 | 2320–2353 | [20], [25] |
| C-H | 2850 | 2850 | 2850 | 2700–2900 | [22] |
| O-H | 3300 | 3340 | 3342 | 2930–3433 | [20] |

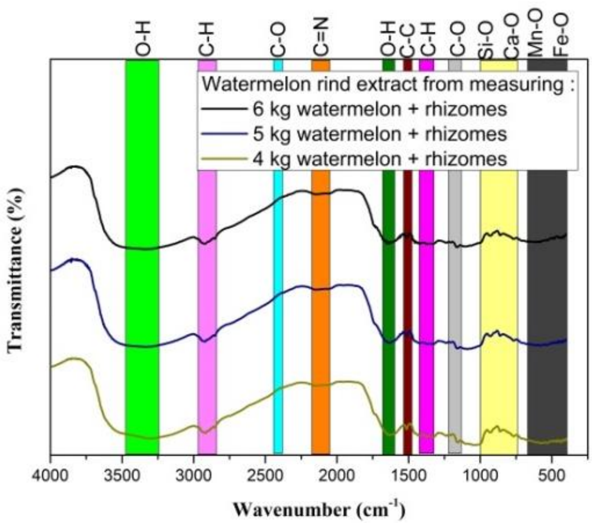


**Figure 4.** Results of FTIR spectra of watermelon peel extract from various variants mixed with rhizome powder.

The results of the FTIR characterization of watermelon rind extract mixed with rhizome powder, there is also the Ca-O function group, which is found in a 785 $cm^{-1}$ wavenumber for watermelon rind extract from measuring 4 kg watermelon that is mixed with rhizomes. Furthermore, in the 767 $cm^{-1}$ wave number for a sample of watermelon rind extract from a 5 kg watermelon which was mixed with rhizome powder, and on a 765 $cm^{-1}$ wave number for a sample of watermelon rind extract from a mixed 6 kg watermelon with rhizome powder. The difference in the analysis of Figure 3 and Figure 4 related to the addition of rhizomes material has the effect of finding C=N and C-C groups as differentiators from the results of both FTIR spectra. From these results it shows that calcium content is true.

### *3.3. XRF Results and Calcium Level Tests*

XRF characterization to find out what content is owned by the sample, and what percentage of its content. While the calcium level test is carried out to determine how large the capabilities of the calcium solubility if dissolved in solvent material such as water, testing the calcium levels indicates that the sample is feasible for medicinal ingredients that are easily dissolved if taken. The XRF test results and calcium levels of watermelon rind extract from watermelon measuring 4 kg, 5 kg, and 6 kg shown in Table 3. From Table 3 it is known in the sample of watermelon rind extract from a 4 kg watermelon with a calcium content of 8.6% with the solubility of 485 ppm. In watermelon rind extract from a watermelon measuring 5 kg has a calcium content of 9.1% with solubility of 490 ppm. Furthermore, in watermelon rind extract from a watermelon measuring 6 kg has a calcium content of 9.2% with solubility of 495 ppm.

In addition, this investigation generates calcium tests at watermelon rind extract mixed with rhizome powder as well as XRF data as shown in Table 4 and Table 5. The sample of watermelon rind extract from a 4 kg watermelon mixed with rhizome powder has a calcium content of 12.70% and a solubility of 495 ppm, and watermelon rind extract from a 5 kg watermelon mixed with rhizome powder has a calcium content of 12.90% and a solubility of 495 ppm. Furthermore, in watermelon rind extract from 6 kg watermelon mixed with rhizome powder has a calcium content of 13.30% and a solubility of 495 ppm, as shown in Table 4.

**Table 3.** Results of XRF and calcium levels of watermelon rind extract from various variations.

| Sample of watermelon rind extract from watermelon measuring | Elemental content (%) | | | | | | | | | | | | Calcium level (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Si | P | K | Ca | Sc | Ti | Cr | Mn | Fe | Ni | Cu | Yb | |
| 4 kg | 56.0 | 6.3 | 1.6 | 8.6 | - | 1.5 | 1.8 | - | 17.3 | 2.1 | 2.2 | 3.0 | 485 |
| 5 kg | 66.1 | 6.8 | 1.4 | 9.1 | - | 0.9 | 1.1 | - | 10.4 | 1.3 | 2.9 | - | 490 |
| 6 kg | 67.8 | 4.1 | 2.2 | 9.2 | 0.2 | 1.1 | 1.1 | 0.4 | 10.8 | 0.7 | 1.2 | 1.0 | 495 |

**Table 4.** Results of XRF characterization (Si, P, S, K, Ca, Ti, V, Cr, and Mn) and calcium levels from various variants watermelon rind extract mixed with rhizome powder.

| Sample of watermelon rind extract from watermelon measuring | Elemental content (%) | | | | | | | | | Calcium level (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Si | P | S | K | Ca | Ti | V | Cr | Mn | |
| 4 kg | 7.60 | 2.00 | 1.90 | 47.80 | 12.70 | 1.20 | 0.05 | 0.19 | 2.80 | 495 |
| 5 kg | 7.40 | 2.20 | 2.10 | 46.40 | 12.90 | 1.20 | 0.04 | 0.18 | 2.80 | 495 |
| 6 kg | 6.50 | 2.10 | 1.90 | 46.40 | 13.30 | 1.20 | 0.03 | 0.16 | 2.80 | 495 |

**Table 5.** Results of XRF characterization (Fe, Ni, Cu, Zn, Ba, Eu, Re, Al, and Yb) and calcium levels from various variants watermelon rind extract mixed with rhizome powder.

| Sample of watermelon rind extract from watermelon measuring | Elemental content (%) | | | | | | | | | Calcium level (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fe | Ni | Cu | Zn | Ba | Eu | Re | Al | Yb | |
| 4 kg | 20.10 | 0.27 | 1.10 | 0.30 | 0.70 | 0.30 | 0.90 | - | - | 495 |
| 5 kg | 19.50 | 0.10 | 0.78 | 0.30 | 0.90 | 0.20 | 1.00 | 1.00 | 0.50 | 495 |
| 6 kg | 21.50 | 0.20 | 0.85 | 0.42 | 0.90 | 0.20 | 0.90 | - | 0.50 | 495 |

In the previous study, the calcium level of watermelon rind is 31 mg/100 g, or 0.031% [5]. While in this study, the watermelon rind extract provided the highest calcium concentration, 9.2% from 45 g, comparable to 4.14 g. In this instance, the need for more calcium is related to the requirement that osteoporosis patients ingest a maximum of 7500 mg (or 7.5 g) of calcium daily. In order to improve the calcium content, rhizome powder is used. From these results, the samples qualify to be employed as medicinal material. The maximum calcium content of watermelon rind extract combined with rhizome powder is 13.30% of 45 g, equivalent to 5.99 g. Calcium levels measured in ppm units show that calcium is easily dissolved in water, making it simpler to employ as a quickly ingested medicine.

## 4. Conclusion

This study successfully uses the destruction method to extract calcium from watermelon rind extract, which is supported by rhizomes, a herbal substance. It has been established that the sample contains calcium based on the findings of the XRD, FTIR, XRF, and calcium testing. Watermelon rind extract from a 6 kg watermelon mixed with rhizomes has the greatest calcium level at 13.30%. The sample's calcium concentration, measured in ppm, has a dominating value of 495 ppm. According to these findings, every sample might be employed as a component in osteoporosis treatment.

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